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Infodemiological patterns in searching medication errors: relationship with risk management and shift work

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Abstract. – INTRODUCTION: Western world health care systems have been trying to improve their efficiency and effectiveness in order to respond properly to population aging and non-communicable diseases epidemic. Treatment of the elderly population is becoming complex due to the high number of prescribed drugs because of multimorbidity. Errors in drugs administration in different health care related settings are an actual important issue due to different causes. Aim of this observational study is to measure the online interest in seeking medication errors information related to risk management and shift work.

MATERIALS AND METHODS: We investigated Google Trends® for popular search relating to medication errors, risk management and shift work. Relative search volumes (RSVs) were evaluated from 2008 to 2018. A comparison between RSV curves related to medication errors, risk management and shift work was carried out. Then, we compared the world to Italian search.

RESULTS: RSVs were persistently higher for risk management than for medication errors (mean RSVs 069 *vs.* 48%) and RSVs were stably higher for medication errors than shift work (mean RSVs 48 *vs.* 22%). In Italy, RSVs were much lower compared to the rest of the world, and RSVs for medication errors during the study period were negligible. Mean RSVs for risk management and shift work were 3 and 25%, respectively. RSVs related to medication errors and clinical risk management were correlated (r=0.520, $p<0.0001$).

CONCLUSIONS: Google Trends® search query volumes related to medication errors, risk management and shift work are different. RSVs for risk management are higher, and they are correlated with medication errors. Also, shift work search appears to be lower. These results should be interpreted in order to correctly evaluate how to decrease the number of medication errors in different health care related setting.

Key Words:
Google Trend®, Medication errors, Risk management, Shift work, Infodemiology, Relative Search Volumes.

Introduction

A change in the health care system towards a patient-centered approach[1], and fast growing Internet use by patients in order to acquire more health information has been widely reported[2].

In particular, as Internet has become a very important platform of knowledge for patients, health care professionals should be prepared to consider this instrument, helping patients in understanding and evaluating the reported information.

Internet analysis is challenging because data sources are very heterogeneous. They include: business transaction, customer databases, medical records, internet clickstream logs, mobile applications, social networks, scientific experiment results, machine-generated data, and Real-time data sensors. Therefore, Internet data analysis is part of a new research branch defined as Infodemiology, which in medical research is useful to describe different diseases impact. Google Trends® is a popular mean for searching data and could be used for examining public interest in multiple health topics[3,4].

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As patients' safety is the main target for all healthcare systems, medication errors during drug administration are a very important issue and the World Health Organization (WHO) requires urgent actions towards medication errors prevention[5-7]. Although a significant scientific production has been developed on this subject, however these preventable events are still frequent[8]. It has been reported that medication errors were serious or very serious in 36% of patients and had potentially moderate severity in almost 40% of patient[9,10].

Also, the real interest about medication errors is still a matter of debate and the question "is there a real interest on this topic?" is still without a definite answer. For this purpose, infodemiology could help to understand this problem[11], and exploring Google Trend®, we could describe what the world is searching for. By using this analysis tool in the area of health phenomena, we think it is possible to increase knowledge greatly.

Different causes have been reported concerning workload, organization and human factors[12]:

- Nurses/patient ratio not intended exclusively as the numerical relationship between nurses and patients (interruptions and distractions);
- Overcrowding, lack of staff[13];
- Knowledge and training needs[14,15];
- Health and wellness of shift workers (tiredness, sleepiness, and low performance)[16].

Deep consideration and knowledge of the phenomenon could be the only way to increase awareness in health care staff. The process should include not only the nursing community that plays a central role in granting patients' safety, but also in medical staff. In a previous paper[16] we suggested that it should be considered the possibility that different work environments of the units may affect the extent of sleepiness and potential medication errors.

Prevalence of elderly patients with several chronic conditions is high, and the management of their treatment could be complex, especially if the number of drugs prescribed is high[17].

In such a scenario, health care professionals working in a different setting are exposed to incur in medications errors, especially during shift work.

The first aim of this study is to describe the global community interest in medication errors and its relationship with shift work and clinical risk management through Google Trend® use. Secondly, it is aimed to compare relative search volumes (RSVs) of different Countries of the world.

Materials and Methods

We adopted Google Trends®, which is a free, publicly available, Internet-based application to search different terms frequency by keywords. Considering an established period of time (weeks, months, or years), Google Trends® shows the RSVs for a given keyword with a value between 0 and 100. Therefore, if RSV is equal to 50, it suggests that half as many searches were carried out in that time period compared to the highest volume of searches (RSV equal to 100). When RSV is equal to 0, it states that no significant searches were carried out. Also, RSVs may compare relative interest between different areas, and adjusts data for population size; therefore, results from populated areas are comparable to less populated. In order to compare relative frequency, to standardize the data between different countries, each data point is divided by the total searches of the geographical area and the time interval that it represents.

We decided to analyze Google Trends® from November 2008 to November 2018 in order to obtain results related to a decade. Subsequently we compared results acquired from all over the world with those referred to Italy.

We explored Google Trends® data for search terms in 3 different languages (English, Italian, and Spanish) in the areas potentially interested by medication errors. Furthermore, we searched term medication errors (+ *errori da somministrazione farmaci* + *errores de medicación*), risk management (+ *gestione del rischio* + *gestión de riesgos*) and shift work (+ *lavoro a turni* + *trabajo por turnos*). Search query volume was filtered by the category "Health" in order to avoid non-health related queries; therefore, avoiding confounding results.

Statistical analysis

Data analysis was directed to show RSVs variations during the study period, comparing different world areas, and assessing correlations between RSVs related to medication errors, shift work and clinical risk management. Results were plotted in graphs and association was tested calculating Pearson correlation after RSVs logarithmic transformation. Statistical analysis was carried out using the Statistical Package for Social Science (SPSS®). A one-side $p<0.05$ was considered statistically significant.

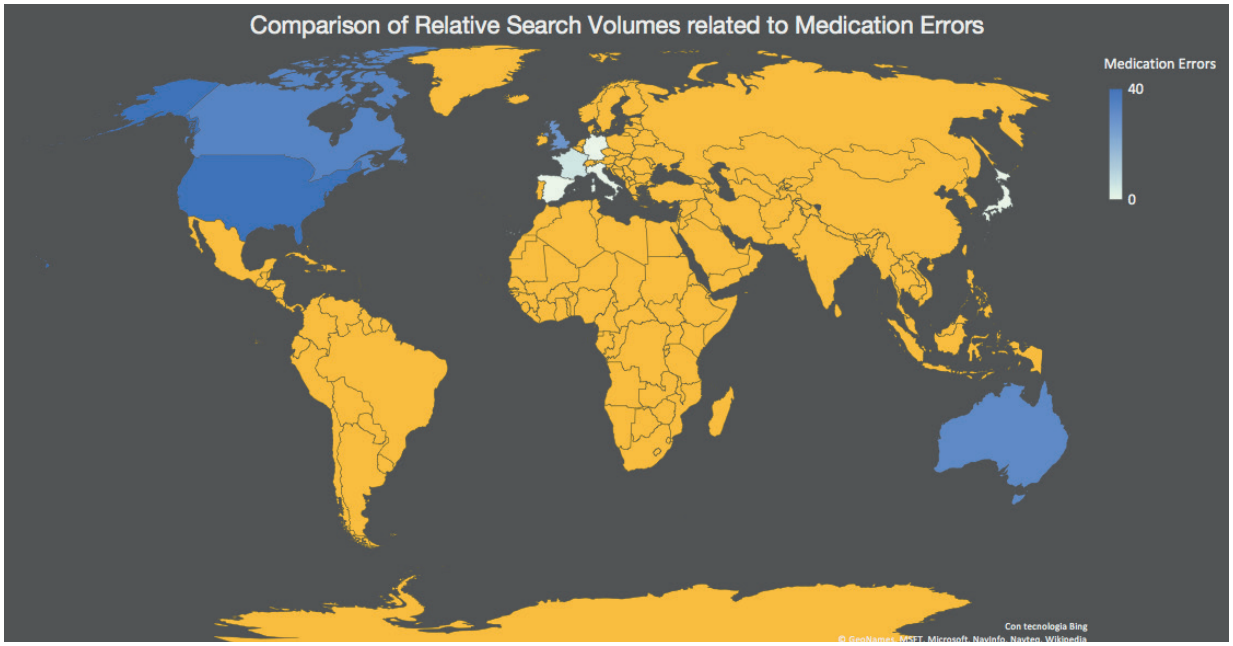

Figure 1. Comparison of relative search volumes (RSVs) related to medication errors.

Results

Worldwide RSVs related to medication errors during the study period is reported in Figure 1. General trends show that interest in risk management is high (69%), followed by medication errors (48%) and shift work value (22%); all data are available at the link in the acknowledgement section.

Monthly RSVs were persistently higher for risk management compared to medication errors during the study period, and RSVs curves for risk management and medication errors were nearly parallel, starting from 2008 (Figure 2).

We compared RSVs related to medication errors in Italy with other countries in Europe, America, Asia and Australia (Figure 3). The majority of European countries showed no interest in medication errors, with RSVs stably around 0%. However, the UK demonstrated a higher interest than the other European countries, since medication errors RSVs was equal to 28%.

This value is very similar to data derived from USA, Canada and Australia. Overall the Anglo-Saxon countries showed very similar RSVs data related to risk management, medication errors and shift work (Figures 3).

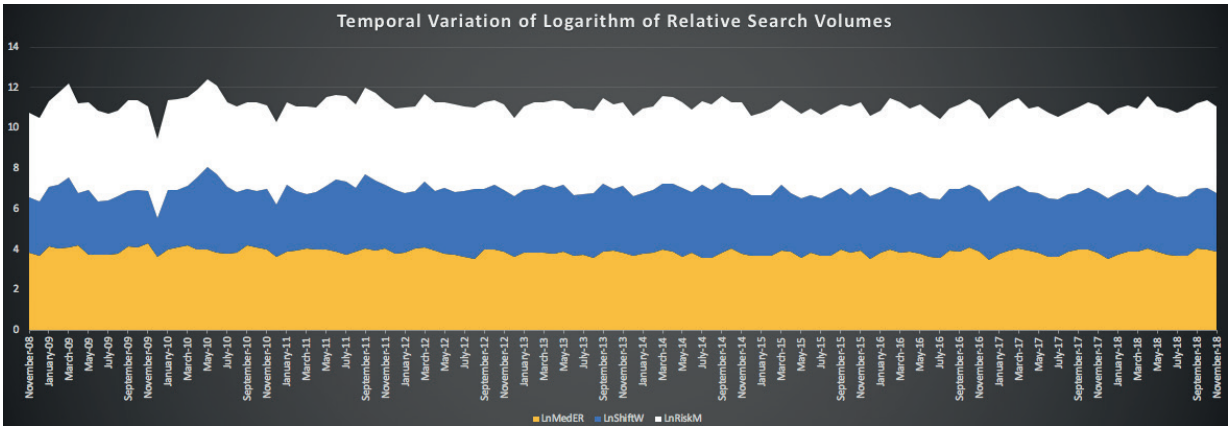

Figure 2. Temporal variation of logarithm of relative search volumes (RSVs).

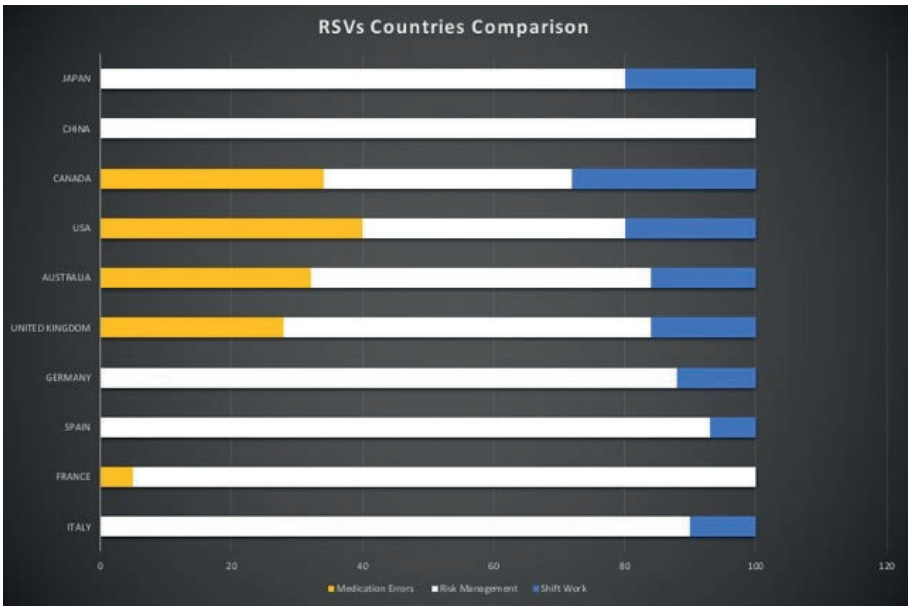

Figure 3. RSVs countries comparison.

The highest RSVs about medication errors were found in Malaysia (100%), the highest shift work RSVs were detected in Australia (100%), and the top RSVs related to risk management were found in Zimbabwe (100%). RSVs related to medication errors and clinical risk management were correlated (r=0.520, p<0.0001; Figure 4).

Discussion

The increasing number of people using web-based sources to improve their medical knowledge provides the opportunity to evaluate trends and interests in this strategic issue. Consequently, infodemiology is progressively gaining consid-

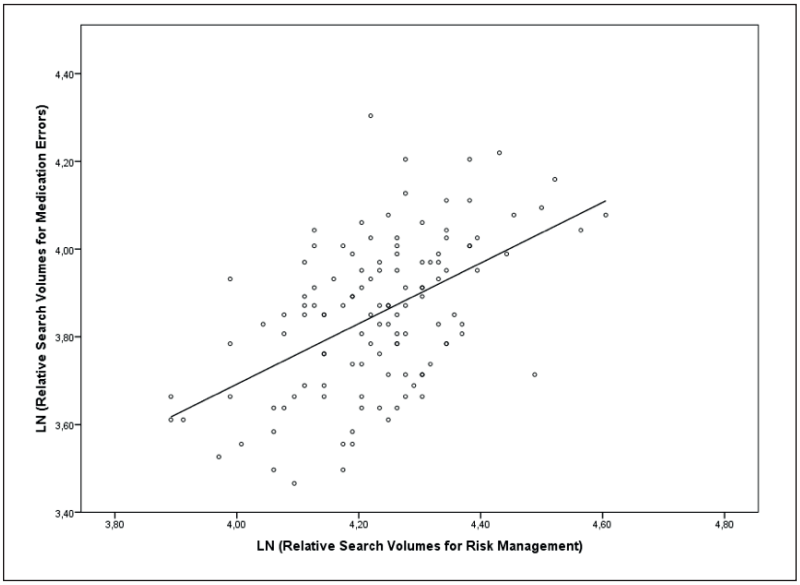

Figure 4. Correlation between logarithm of relative search volumes (RSVs) for medication errors and risk management.

eration and interest by researchers in different branches of science.

Undoubtedly, this huge amount of data is creating new challenges, but it also offers opportunities[18]. Volume, variety, velocity, veracity, value, variability, volatility, and validity define Internet data[4]. Analysis of web-based behavior and behavioral changes could help us to understand better and interpret patients and healthcare workers interaction[19].

For example, the peak shown in May 2010 could be explained by the publication of data on the characteristics of the organization of work in workers' health (Occupational health supplement - OHS - included in the NHIS 2010 sample adult questionnaire)[20]. Google Trends® is a reliable tool for evaluating RSVs temporal patterns and predicting interests. Recently, different studies based on an assessment of online search interest for cancer were reported[21,22].

Google Trends® appear a valuable source of information in the field of health Internet data, showing interest changes in different countries or regions over a selected period of time, or a specific language.

According to Prisma guidelines, Nuti et al[3] analyzed studies utilizing Google Trends® for health care research. The authors evaluated seventy studies that were classified into 4 topic domains: infectious disease (27%), mental health and substance use (24%), non-communicable diseases (16%), general population behavior (33%). Overall 27% of articles utilized Google Trends® for casual inference, 39% for description, and 34% for surveillance. Among surveillance studies, 92% were validated against a reference standard data source and 80% of studies performed correlation. However, only 7% of articles were reproducible based on complete search strategy documentation[3]. Recently, Mavragani et al[4] performed a systematic review showing different approaches to Google Trends® in health-related topics. They reported that 23% of studies evaluated data for analyzing seasonality, 39% used correlations, 33% modeling and only 8.7% for predictions and forecasting[4].

To our knowledge, no study has ever analyzed Internet data on medication errors.

The PubMed search on risk management, updated to December 2018, collected over 271,000 articles. Typing the same Mesh term and selecting only papers dealing with epidemiology, drastically reduced the final number to 8 papers. In the same way searching for the Mesh term "medication errors" and again selecting results dealing with "epidemiology" produced 121 results. The same search using the mesh term "shift work" schedule ended up with 144 manuscripts.

In our opinion searching in PubMed, one of the most important search engines accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics, did not necessarily provide an impressive amount of information.

Google Trends® could be interpreted as a non-specific search engine able to test general sensibility to a specific query.

Google search query volumes related to medication errors, risk management and shift work are different. More in detail, RSVs for risk management are higher and seem to be related to medication errors, suggesting that the two queries are frequently associated. This finding suggests that people searching for the two items are probably the same. Queries on shift work appear to be scarce especially in European countries. In Italy, these queries are completely lacking, and this suggests that health care authorities need to emphasize such an item. Anglo-Saxon countries behave differently, probably because of a different work organization. Probably the updating knowledge for nurses and physicians are different. We cannot discuss health professionals' skills in pharmacology, however, interest in therapy administration safety does not appear to be homogeneous in the world. In 2017, WHO launched the global campaign to halve therapeutic errors by 2022[6], suggesting that health care professionals must regularly update their knowledge especially for the prevention of medication errors[13].

Despite the initiative, Infodemiology has not been showing an increasing interest in this phenomenon. A problem that continues to entail too high social, economic and human costs for a system aimed at human assistance[23].

We are aware of some limitations in our study. In order to estimate effectively tracking search behavior, Google Trends® needs to be carried out on large populations; therefore, results may be limited only to developed societies.

We did not query Google Trends® in all different languages around the world, but only in English, Spanish (spoken by a high percentage of the western populations) and Italian (in order so detect what's going on in our country). However, since the majority of scientific production is written in English, it is probable that a significant percentage of RSVs regarding risk management,

medication errors and shift work is performed by hospital managers. Also, the English language has to be known by managers in order to search for information aiming at improving hospital efficiency.

Other search engines, apart from Google, are also used by people. However, a recent study by the Faculty of Medicine of the University of Geneva comparing Google and health specialized search engines found that the majority of the participants preferred Google results while the specialized search engines showed to compete in specific topics[24].

Data collected from multiple sources, could include low quality data difficult to distinguish. However, the amount of data analyzed by Google Trends® is huge and such a fact could compensate errors.

Finally, General Data Protection Regulations are different in the various countries, and this aspect could affect data collection.

We are conscious that Infodemiology could not analyze in depth such a complex phenomenon, moreover we merely would detect the worldwide interest for it because preventing errors saves money and saves lives[6].

However, Cervellin et al[25] showed no correlation between data captured from Google Trends® and epidemiology of 3 different medical conditions[25]. These authors concluded that Google Trends® had limited reliability for defining the epidemiology of medical conditions with minor media coverage, or relatively rare diseases with a higher audience. They suggested that Google Trends® appeared to be influenced by the media clamor than by true epidemiological burden. Previously Iaboli et al[26] underlined undisclosed costs and risks, emphasized benefits, unrevealed financial conflicts of interest and exaggerated claims in Italian print media[26]. On the other hand, in the current paper we evaluated 3 items not covered by media, and we think that our results can be taken for granted of public health care organizations, showing a widespread epidemiological interest for medication errors.

Conclusions

Nowadays, safety about drugs and the use of devices is a crucial item[27-30]. Beside traditional data collection methods, epidemiological studies need new tools that are better suited for the present dynamic populations and Internet presents a powerful alternative[31,32]. The ongoing communication revolution (mobile, social, real-time) in the way people communicate has originated a new kind of epidemiology, regarding populations health dynamics around the world[33]. Eysenbach[11,34] defined Infodemiology as the method that allows evaluation of distribution and determinants of information in an electronic medium with the ultimate aim to inform public health and public policy, although further development and standardization are needed.

The use of Google Trends® by researches has increased dramatically in the last decade and Internet data analysis has been changing continuously[35].

Analyzing data has become faster and cheaper during the last decade, leading to an impressive amount of routinely generated data waiting to be examined and interpreted. Internet Data in medicine should be used to provide health profiles and eventually predictive models. Moreover, new sources of information such as social media should be considered dealing with medications errors[36]. We conclude that Internet data analysis will be possible to impact policies regarding patients' safety that in actual health care systems should be increased and sustained. So, our answer to the question "is there a real interest on this topic?" is: not enough.

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Google Trends®

All data could be available at

https://trends.google.it/trends/explore?cat=45&date=2008-11-01%202018-11-01&q=medication%20error%20%2B%20medication%20errors%20%2B%20errori%20somministrazione%20farmaci%20%2B%20errores%20de%20medicación,shift%20work%20%2B%20lavoro%20a%20turni%20%2B%20trabajo%20por%20turnos,risk%20management%20%2B%20gestione%20del%20rischio%20%2B%20gestión%20de%20riesgos

Conflict of Interests

The authors declare no conflict of interest. The funders had

no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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